'Cloudy' Project to Answer Murky Questions

'Nobody' Will Fly New Climate-Research Aircraft

Do clouds hold the key to global warming?

With help from a high-flying unmanned aerospace vehicle — a UAV — carrying sophisticated instrumentation, a multi-agency team of researchers is investigating the role clouds play in moderating and distributing the sun's energy throughout Earth's atmosphere. The answers they find, scientists say, may help unlock Mother Nature's secrets behind global climate changes.

"The atmospheric radiation measurement [ARM]–UAV program focuses on one of the most significant areas of uncertainty in understanding global climate change: the interaction of the sun's radiant energy with Earth's atmosphere and with clouds," says Will Bolton (8102), deputy technical director for the ARM-UAV program.

"As the sun's energy enters the atmosphere," he continues, "it is absorbed or reflected. Improving our knowledge of this phenomenon is crucial to understanding large-scale problems, such as global warming. The UAV platform allows us to fly solar radiometers and other instruments into the atmosphere above and below the clouds to better understand what happens to the radiant energy."

Managed by DOE and funded through the Defense Department's Strategic Environmental Research and Development Program, the ARM-UAV project will advance climate research by taking advantage of the unmanned aircraft's high-altitude, long-endurance capabilities.

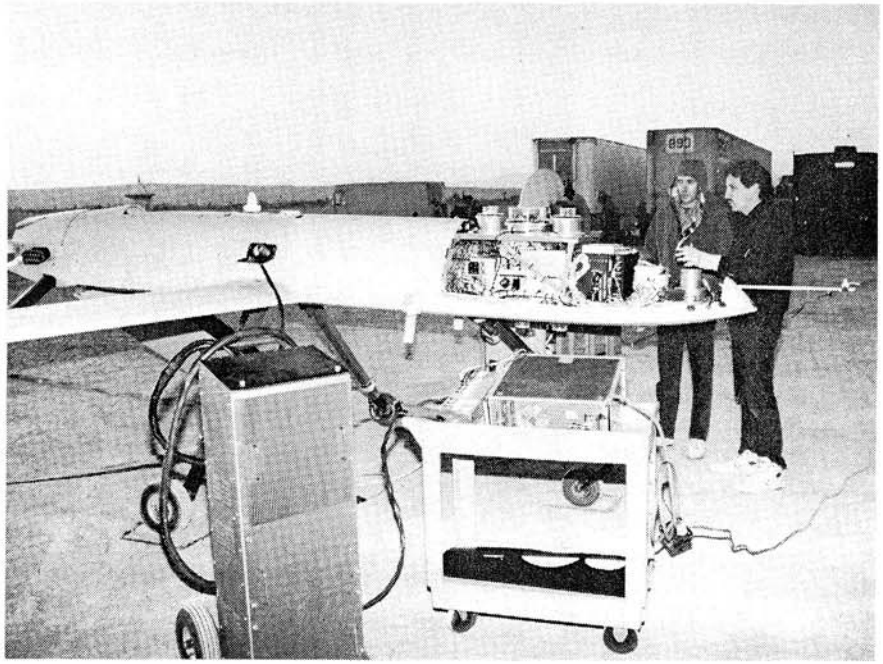
Sandia is part of a program that may help substantiate or disprove current theories about global climate trends.

Sandia is the technical director and overall integrator for the multi-lab program. Other major participants include NASA Ames Research Center, with flight endurance up to 48 hours can provide nearly continuous coverage of an area anywhere in the world for extended periods."

Will continues, "DOE has identified three primary major CART sites with highly variable weather patterns — the Southern Great Plains region in Oklahoma, the tropical western Pacific, and Alaska's North Slope — where it will place surface-based instruments. With the ARM-UAV, we can make airborne measurements not possible from the ground, as well as help calibrate and validate surface- and space-based measurements."

Looking at Global Climate

According to Will, the ARM-UAV program may help scientists substantiate or disprove current theories aimed at explaining major global climate trends. For example, the "thermostat hypothesis" contends that when the sun's energy hits the ocean does it affect the formation of clouds, and what is the long-term influence on global climate?' " he continues. "By helping scientists explore different scenarios and improve their models, the ARM-UAV program will provide valuable data that can be translated into real-world applications." •



ALL SYSTEMS GO — Will Bolton (8102, left) and Ron Renzi (8111) examine atmospheric-radiation measurement instruments on a General Atomics "Gnat." This remotely controlled craft last month carried instruments to study what happens to the sun's radiant energy when it enters Earth's atmosphere. Later, aircraft will be used that can stay aloft taking measurements for as long as 48 hours.

Los Alamos National Lab, Lawrence Livermore National Lab, University of Wisconsin, Harvard University, Colorado State University, Pacific Northwest Laboratory, and Brookhaven National Laboratory.

'Gnat' Made First Flight

To kick off the project's demonstration phase, the team instrumented an "off-the-shelf" craft, a General Atomics "Gnat," for the first-ever climate-related measurements made with a UAV. The Gnat made a successful 2½-hour engineering test flight near California's Edwards Air Force Base on Nov. 13.

The remotely controlled UAV used radiometric instruments provided by NASA to measure radiant energy flux at several altitudes, reaching a maximum height of 22,700 feet. The payload also included a commercial meteorological package to measure temperature, pressure, and water vapor concentration throughout the bow-tie shaped flight pattern at three different altitudes.

"The first flight served as an engineering test to demonstrate the utility of a UAV platform for climate research, and to make sure our instruments worked correctly," Will explains. "The bonus was that we collected valuable scientific data and made important measurements of radiant energy."

A second demonstration, scheduled for early 1994 at DOE's north-central Oklahoma Cloud and Radiation Testbed (CART) site, will expand the research effort by making measurements in conjunction with ground-based instruments at CART. Over the next two years, research will incorporate more-sophisticated instruments and more-capable UAVs. In the final phase, advanced UAVs such as the Aurora Perseus aircraft will eventually carry instrument payloads to the top of the troposphere, approximately 20 kilometers above Earth's surface.

"The interim-phase flights will last up to 24 hours," says Will, "and the full-capability UAV

surface in the tropical western Pacific northeast of Australia — part of the "heat engine" that drives the global climate — it warms the large pool of water to a certain temperature, then stops, even though additional energy is available. This feedback mechanism helps regulate the temperature and moderate the effect of global warming.

The reason is still unclear and controversial. Some researchers believe that when the ocean temperature hits a certain limit, the convection process conveys more water vapor high into the sky. That forms a large blanket of cirrus clouds that shade the surface by reflecting away energy, which limits the temperature rise. Other researchers believe that evaporation plays the major role in cooling the ocean surface and limiting the temperature rise. By measuring the effects of clouds and water vapor, ARM-UAV will contribute to the understanding of such key phenomena.

Information collected by the ARM-UAV program will also help improve global climate models used by the federal government to create environmental policy. "Government decisions to reduce

"Interim-phase flights will last up to 24 hours, and the full-capability [aircraft will fly] up to 48 hours."

emissions of carbon dioxide and other greenhouse gases can have a tremendous economic impact by affecting power production, transportation, and other key industries," Will explains. "If we can better understand the cloud feedback mechanisms that influence the degree to which these gases affect global temperature, the government can make more-informed policy decisions.

"The program also enables climate modelers to ask important questions, such as 'If we limit carbon dioxide or aerosols to a specific level, how